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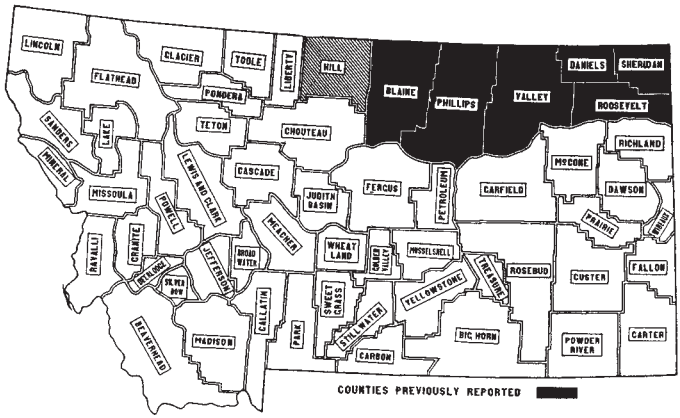
SOILS OF HILL COUNTY



SOIL RECONNOISSANCE OF MONTANA

PRELIMINARY REPORT

BY

L. F. GIESEKER

IN CHARGE OF SOIL SURVEY
COOPERATING WITH THE BUREAU OF SOILS
UNITED STATES DEPARTMENT OF AGRICULTURE

MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

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The primary purpose of this soil reconnoissance of Montana is to obtain general information in regard to (1) the soil resources of the state, (2) the adaptability of the topography to agriculture, and (3) the carrying capacity of the different soil areas for live stock. Such a survey is of a general nature and the areas shown on the soil and topographical maps simply represent the prevailing character of the soil and topography.

The Hill County report is the seventh to be issued. Reports on Sheridan, Daniels, Roosevelt, Valley, Phillips, and Blaine counties are also available and may be obtained from the Montana Experiment Station, Bozeman, Montana.

SOILS OF HILL COUNTY

BY

L. F. GIESEKER

ASSOCIATE AGRONOMIST

LOCATION

Hill County is located in the north-central part of Montana, and forms the northeastern portion of an area known as the "Triangle," extending north from the city of Great Falls in the directions of Havre and Cut Bank. The county, named in honor of the late James J. Hill, founder of the Great Northern Railway system, was created along with Blaine County in 1912 from the northern portion of Chouteau County. In 1914 Toole County was organized from Hill and Teton counties, and in 1919 Liberty county was carved out of the western half of Toole and the northwestern part of Chouteau. Since 1919 Hill County has covered an area of 2892 square miles, included between Townships 28 and 37 north of Base Line Montana and Ranges 3 and 17 east of Principal Meridian Montana. The county has a general rectangular shape, although its southern line projects one to two townships to the south in the southwestern and southeastern corners. The average distance across the county from east to west is about 57 miles and from north to south varies from 48 to 60 miles. The Rocky Boy Indian Reservation includes the greater part of the Bear Paw Mountain area in the county. A portion of Beaver Creek Canyon, south of Havre, is a national park, which was set aside in 1912.

PHYSIOGRAPHIC FEATURES

Hill County lies in the glaciated portion of the Great Plains. The greater part of the county is a rolling plain, characterized by broad glaciated divides, sloping gently in an easterly and southeasterly direction. The larger streams are intrenched in narrow valleys, bordered with rugged breaks, which are locally eroded into bad lands. The Bear Paw Mountains rise in the southeastern part and several high buttes in the northeastern part. Erosion has not greatly changed the surface features of the drift-covered places since the time of glaciation.

Wisconsin glaciation.—The Keewatin ice sheet, which developed in central Canada during the late Wisconsin glaciation, spread over the greater part of north-central Montana. It extended well up the

slopes of the Bear Paw Mountains and covered the plains of Hill County.

The drift-covered plains have a hummocky, billowy relief except on some of the more gently sloping divides, where shallow lake depressions and low mounds and ridges are the more noticeable features. The southwestern and western parts of the county were more feebly glaciated than the central and eastern parts. The depth of drift varies greatly, but in the more intensely glaciated sections it ranges between 15 and 30 feet. The more stony morainic tracts, characterized by stony mounds, ridges, and pot-holes, occur along the larger streams, such as Milk River, Sage Creek, and Red Rock Coulee, and locally on the slopes of the divides and mountains.

The drift-covered plains rise from elevations of 2600 to 2700 feet along the Milk and Marias rivers in the east-central and southern parts to 2900 to 3300 feet along the international line. Elevations of over 3000 feet are recorded (1) in the northwestern and northeastern corners, (2) in the west-central part, and (3) on the divide east of Milk River, south of Wild Horse Lake. The average elevation of the drift-covered area is approximately 2800 feet. The glaciated slopes of the Bear Paw Mountains rise abruptly from the plains south of Milk River.

Bear Paw Mountains.—The Bear Paw Mountains rise in Hill and Chouteau counties and extend east into Blaine County as two fairly well-defined ridges separated by a broad basin. In Hill County the mountains tower several thousand feet above the plains in the southeastern corner and their peaks, such as Mount Bear Paw, Bates, and Otis, have elevations of 6000 to 7000 feet. The peaks and ridges of the Bear Paw Mountains are well rounded. Dikes of ancient trap rock occur on the mountain slopes and also appear as buttes, such as Saddle and Square near the base of the mountains.

Signal and Saddle Buttes.—Signal Butte is a local dome rising above the glaciated plains in the northeastern part of the county. Its slopes are sharply rolling. Saddle Butte, a sandstone-capped elevation surrounded by bad lands, is located in the east-central part of the county southeast of Havre. West of Simpson a high glacial mound, one of the prominent landmarks in the north-central part of the county, rises above the breaks of Milk River.

Wild Horse Lake.—Wild Horse Lake occupies an ancient stream depression which is dammed with drift in the north-central part of the county. The lake bed was probably covered with water at least

a portion of the year, before the streams entering it from the north were diverted on to irrigated land in Canada. A remnant of the old lake still covers a few acres east of Oldham. Other lakes, such as Thibedeau in the northeastern part, occupy similar depressions and are of the same general character.

Pre-glacial valley of Missouri River.—A wide depression, through which Missouri River is said to have flowed before the time of glaciation, encircles the Bear Paw Mountains in the southeastern part of the county. Big Sandy Creek enters the depression in Chouteau County and Milk River east of Havre. It is a well-defined stream course averaging several miles in width and bordered by gently rising uplands. The bottom of the depression along Big Sandy Creek is more or less terraced and covered with hummocky drift. Similar depressions are found also in the north-central part of the county.

Bad lands.—Milk River Valley is bordered by rugged breaks, which are locally eroded into bad lands. The sandstones and shales exposed in the breaks belong to the Judith River and Two Medicine formations.

DRAINAGE

Glaciation did not greatly modify the physical features nor appreciably influence the drainage in north-central Montana. The larger streams were dammed and their valleys partly filled with drift, but when the ice receded most of the streams returned to their former courses. One of the more important changes made in the drainage of this part of the state was the diversion of Missouri River from its pre-glacial course. Geologists claim that before the time of glaciation Missouri River occupied the depressions through which Big Sandy Creek flows and the valley of Milk River east of Havre. The present course of this stream south of the Bear Paw Mountains is said to have been developed during the time its waters were impounded in the north-central part of Chouteau County.

Hill County is drained by the Milk and Marias rivers, except for several streams heading in the Bear Paw Mountains and flowing south into Missouri River. Marias River drains the southwestern part and Milk River and its branches the remainder of the county.

MILK RIVER DRAINAGE BASIN

All the larger streams in the county except Marias River enter the pre-glacial valley of Missouri River. Milk River and Sage Creek enter from the north; while Big Sandy, Beaver, Bullhook, and Box

Elder flow in from the south. West Fork of Milk River and Red Rock Coulee in the northeastern part enter the old valley across the county line in Blaine County. Milk River is the main stream in Hill County.

Milk River.—The main forks of Milk River head on the Milk and St. Mary's divide, east of the main range of mountains, in Glacier County, and flow northeast into Canada where they unite to form Milk River. The stream crosses the international line in the northwestern corner of the county and takes a general southeasterly course until it enters the preglacial Missouri Valley, where it turns to the east. The stream enters the county at an elevation of 2700 feet and leaves it at about 2450 feet. Its usual volume of water is increased during the early spring run-off and again in May and June when it is swollen by the seasonal rainfall and by the melting of snow on the high divides and in the mountains. The summer flow is artificially maintained by water stored in the Sherbourne Lakes for the Milk River Irrigation Project.

The valley of Milk River above Havre averages about one-half mile in width and is bordered by rugged sandstone breaks, rising 75 feet or more. The stream meanders through a narrow, sage-covered flood plain, fringed with cottonwoods and willows below the sombre-colored colluvial slopes extending locally down to the stream. East of Havre the valley spreads out to about one mile in width and the sandstone breaks give way to steep, gravelly, drift-covered slopes. In this part of the valley, the bottom is terraced and well wooded.

Sage Creek–Milk River divide.—The crest of the divide between Sage Creek and Milk River rises a few miles east of Sage Creek and slopes to the southeast. The northern portion of the divide about King, Gold Stone, and Fairchild post offices has a gentle relief but is quite scabby. The land becomes more rolling and hummocky to the south, and along Sage Creek in the vicinity of Hausman post office stony ridges and mounds are conspicuous. A stony ridge rises northwest of Fairchild post office and parallels Milk River at a distance of 3 or 4 miles. The land along the river is broken with deep coulees. Canada and Kennedy creeks are the larger intermittent streams and are deeply intrenched in the sandy shales of the Two Medicine formation.

The central portion of the divide has a more easterly slope and above the breaks of the river is quite rolling and stony. The intermittent streams entering the river from the west head in scabby basins

and flow through deep coulees within 3 to 5 miles of the stream. Chain Lakes, which have been proposed as a secondary reservoir for the Milk River Irrigation Project lie in a deep recess between a belt of high, drift-covered hills. The land west of the lakes is undulating, while that to the east is more hilly and hummocky.

The southern part of the divide slopes to the southeast. South of Kremlin, sand hills cover a small area and above Big Sandy Creek the gentle slopes are quite scabby.

Area east of Milk River.—East of Milk River, south of Wild Horse Lake, the land rises to the east for 6 to 8 miles and breaks into the drainage basin of Red Rock Coulee. Rolling sand hills border the lake and farther south lies a wide sandy depression, in which Simpson and Miller post offices are located. The depression runs to the northwest and its southern slopes are very hummocky and stony. North of the depression the land is rolling, with a few sharply rolling tracts west of Wild Horse Lake. Spring Creek is an intermittent stream with a few perennial water-holes along its course. It crosses the depression from the north and is deeply intrenched within 4 to 5 miles of the river. Other prominent physical features in this part of the county are a stony hummocky tract about Toledo, bad lands surrounding Saddle Butte, and low gravelly hillocks, which are most numerous about Cottonwood post office.

West Fork of Milk River.—The West Fork of Milk River heads in Canada and flows southeast through the northeastern corner of the county. It is the largest perennial stream entering Milk River from the north in this part of the state. The stream meanders through a narrow, open, terraced valley bordered by low gravelly slopes. It drains an undulating scabby area, except for a few sharply rolling tracts along Woodpile Coulee. Creedman's Coulee is a small intermittent stream in the undulating scab lands. South of Creedman's Coulee, in R. 15 E., Signal Butte rises 100 feet or more and its slopes are eroded into sharply rolling land.

Red Rock Coulee.—Red Rock Coulee is an intermittent stream heading on the divide east of Milk River in the vicinity of Cottonwood post office. It flows southeast and empties into Milk River across the county line. The land along its upper course is rolling and broken, but lower down it has a more gentle relief. South of Thibedeau Lake, the stream is bordered on the north by a stony ridge. Coal Coulee is enclosed in a narrow valley below the rolling divide to the south.

Lohman's and Staton's coulees are the larger branches of Red Rock Coulee. Lohman's Coulee heads on a shaly dome, southeast of the sand-hills below Wild Horse Lake. It flows through an ancient stream valley, which is filled with drifts south of the reservoirs shown on the topographic map. The ancient stream valley is bordered on the north by rolling tracts of sand-hills and on the south by sharply rolling land. Below the reservoirs the land along the stream grades into the scab-land area. The reservoirs supply water to several hundred acres of hay land. Staton's Coulee has the same general character as Lohman's Coulee, and drains a similar area. Its southern branch in the vicinity of Amos post office drains a rather sharply rolling section.

Sage Creek and area west.—Sage Creek heads in the Sweet Grass Hills, enters Hill County in the northwestern part, and flows southeast, emptying into Big Sandy Creek in the south-central part of the county. The stream flows through a narrow valley, which widens out to about 1 mile in width for 20 miles or more northwest of Gildford. Its waters are impounded in several natural reservoirs northwest of Hausman post office. Gravelly sandy drift covers the valley slopes above Gildford, but below, sandstone breaks rise locally above the stream.

Tootsie and O'Brien creeks are the larger intermittent branches of Sage Creek. These streams head on the eastern slopes of the Sweet Grass Hills and drain a rolling area. A few stony mounds and ridges occur along Sage Creek, and locally above Inverness and Hingham. Glacial lakes are not numerous but north of Rudyard a few streams enter enclosed lake basins. The rolling land in the vicinity of the Great Northern Railway rises to the west without noticeable breaks in the contours.

Big Sandy Creek.—Big Sandy Creek heads in the southwestern part of the Bear Paw Mountains and enters the pre-glacial valley of Missouri River in Chouteau County. The stream follows the west side of the valley and empties into Milk River River west of Havre. North of Fort Assinniboine the stream enters a narrow enclosed valley, while the ancient stream course turns east between Black and Squaw buttes. Big Sandy Creek is a fair-sized perennial stream entrenched 10 to 15 feet in a narrow flood plain, which below the mouth of Sage Creek is about one-half mile in width.

The pre-glacial valley of Missouri River ranges between 3 and 5 miles wide. It is bordered on the west by a low sandstone escarpment and on the east by drift-covered slopes. Gravelly sandy terraces

and low hummocks cover the valley floor above the recent stream deposits. Lakes and depressions occur between the streams crossing the valley. The recent alluvium deposited by the stream is very heavy and often approaches a greasewood alkali flat.

Faulkner's and Halfway coulees drain a high rolling glaciated section in the southern part of the county. The area is characterized by high ridges and wide deep basins.

Beaver, Box Elder and Bullhook creeks.—The land east and south of the pre-glacial valley of Missouri River rises rapidly in the direction of the Bear Paw Mountains. Square, Squaw, and Saddle buttes are local exposures of ancient trap rock along the valley. The slopes of the mountains are eroded into broken ridges between such streams as Beaver, Box Elder, and Bullhook creeks. The tillable land in this part of the county lies in irregular tracts on the less broken slopes. East of Saddle Butte is a fair-sized tract of rolling land, but elsewhere the tillable land is quite rolling.

Beaver Creek heads in a high, wooded basin below Mount Bear Paw and flows north through an attractive rock-walled canyon, the more scenic section of which has been set aside as a national park. Box Elder Creek also heads in a high basin east of Mount Bear Paw and flows north, emptying into Milk River east of Saddle Butte. Another stream bearing the name of Box Elder Creek rises west of Mount Bear Paw and flows in a northwesterly direction, joining Big Sandy Creek west of the town of Box Elder. Bullhook Creek heads below Mount Reynolds and flows north through a deep gorge along most of its course. Other streams heading in the mountains flow through open valleys, bordered by rugged mountain slopes.

MARIAS RIVER DRAINAGE BASIN

Marias River, one of the larger streams, heads in the main range of the Rocky Mountains and drains a small area in the southeastern part of this county. The stream flows through a wide basin in which its narrow valley is sunk 100 feet or more. The breaks of the valley are covered with drift, below which dark-colored shales outcrop. The stream meanders through a narrow, sage-covered flood plain, which is locally covered with wash from the shaly breaks. The basin north of the river grades into a low, broken divide along Black Coulee. The land north of the coulee consists largely of high rolling ridges between wide, gently sloping depressions. The broken slopes of Goosebill Dome

extend down to the breaks of the river on the south. The intermittent streams entering Marias River are all very deeply intrenched in narrow valleys.

SETTLEMENT

The area north of the Marias and Missouri rivers as far west as the main range of mountains was an Indian reservation almost up to the time of the completion of the Great Northern Railway in this part of the state in 1888. Travel through Milk River Valley was restricted during the sixties and seventies, unless accompanied by a military escort. The present boundaries of the older Indian reservations were not established in northern Montana until 1885, and the unreserved public lands were not thrown open for settlement until 1887. The Milk River Valley east of Havre and the grazing land about the Bear Paw Mountains were largely sectionized during the late eighties and nineties, but the remainder was not sectionized until some years later.

History.—Captain Lewis, of the Lewis and Clark Expedition, ascended Marias River during the summer of 1806, and was the first explorer to give information in regard to this part of the state. Lewis found the Peigans and Blood Indians occupying the area along Marias River, and the Gros Ventres, an allied tribe, located about the Bear Paw Mountains. Soon after the expedition returned to St. Louis, fur-trading companies began exploiting the territory. The American Fur Trading Company established a permanent post at Fort Benton in 1842, and during the seventies Fort Belknap was built near the present site of Chinook by local Indian traders. Trappers and Indian traders did not venture into the Blackfoot territory until the late forties and emigrant trains were often attacked as late as the eighties.

The Stevens Expedition, which was organized in 1853 to investigate the feasibility of building a railway through Northwest Territory, passed through this part of the state during the summer of 1854. It left behind a small detachment under Lieutenant Mullan to make a more detailed survey of the area during the following fall and winter. This was followed by other expeditions, through which the resources of the area became known, and finally the transcontinental lines were constructed through the state in 1883 and 1888. The main line of the Great Northern Railway as far west as Havre and the branch line to Butte were completed in 1887, but through traffic to the coast was not established until several years later.

After the Custer massacre in the southeastern part of the state the government took steps to prevent further outbreaks among the Indians. Fort Keogh, in the eastern part of Yellowstone Valley, and Fort Assinniboine, in the upper part of Milk River Valley, were established in 1879. These military forts were successful in preventing further concerted action among the Montana Indians.

The Fort Assinniboine military reservation covered a large tract along Beaver Creek, extending back into the Bear Paw Mountains. The fort was operated up to 1911, when the buildings and about 2000 acres were turned over to the state for a branch experiment station and the mountainous portion of the reserve was set aside as a reservation for the Rocky Boy Indians. The remainder was not thrown open for settlement until 1916. The old military roads leading from the fort into the Bear Paw Mountains and the freight trails to Fort Benton, Virgelle, Cow Island, and Fort McClelland in Canada are readily located in different parts of the county.

Time of settlement.—Settlement in northern Montana dates from the time the unreserved portion of the Indian reservations was thrown open in 1877, although a few squatters appeared around trading posts before this time. Stock raising was taken up south of the Marias and Missouri rivers during the early eighties, but the industry did not develop north of these streams until after the Indians were confined to the present reservations. Most of the early live-stock companies had their local headquarters in the mountains and in the valleys of the larger streams. The land filed upon during the late eighties and nineties consisted largely of stream bottoms, the possession of which controlled the grazing in the uplands. Large cattle companies operated in the area up to 1903, when a severe drought set in and the industry passed into the hands of smaller cattlemen. These smaller companies prospered up to 1910, when the public ranges were settled and fenced under the so-called dry-land movement. The public range land which was suitable for farming was largely homesteaded in tracts of 160 and 320 acres between 1910 and 1914. The number of towns and urban centers increased rapidly during this period and facilities were provided for serving a dense population.

Settlers.—Most of the early stock companies operated on foreign capital and their managers were largely of English and Scotch descent. The people attracted to the public lands during the dry-land movement came largely from the industrial centers and agricultural districts of the north-central states, although during the latter part of the

movement a few came in from Washington and other western states. Norwegians and Germans predominate over other nationalities in some localities, but most of the people are native born. A few Japanese, Chinese, and Negroes are found in the larger towns.

Population.—Hill County was sparsely settled during the time when stock raising was the chief industry, but between 1910 and 1917 the urban and farm population grew rapidly. The United States census report for 1920, which was the first to be made after the western part of the county had been cut off to form Liberty County, placed the total population at 13,958, of which over 100 were Indians, located on the Rocky Boy Indian Reservation. The 1925 agricultural census places the farm population at 4,966. The present estimated total population is 13,700.

Towns.—Havre, the county seat and port of entrance from Canada, is located in the east-central part of the county on the main line of the Great Northern Railway. It is also the junction of a branch line running southwest to Great Falls, Helena, and Butte. Havre, with its large repair shops and yard facilities, is one of the more important division points on the main line of the railway. It has a population of approximately 6,000 and next to Great Falls is the chief distributing point in the northern part of the state. Gildford and Inverness are the larger towns in the western part of the county, while Hingham, Rudyard, and Kremlin are trading centers on the main line west of Havre. Box Elder, located on the branch line near the Hill–Chouteau County line, serves a large agricultural and stock section west of the Bear Paw Mountains. The Northern Montana Branch Station is located on the old Fort Assinniboine military reservation 7 miles southwest of Havre.

Transportation and markets.—The main line of the Great Northern Railway runs west through the south-central part of the county, while the Havre-Butte branch runs down the pre-glacial Missouri River Valley southwest of Havre to Great Falls. The main line provides facilities for the shipment of grain, live stock, and live-stock products, which make up most of the exports, directly to eastern and western markets, such as Chicago, St. Paul, Spokane, and Portland. The branch line provides means for moving grain and live stock as well as the more perishable farm products to the larger industrial centers in the state, such as Great Falls and Butte.

The Roosevelt Highway, also known as "Glacier Trail," parellels the main line of the railway through the county. It is surfaced with

gravel and maintained in fair condition during the tourist season. Wild Horse Trail, leading northwest from Havre into Canada, is one of the more important emigrant trails. It is a graded road and is maintained in good condition. The Havre-Great Falls road which parellels the branch railway line is improved and maintained in good condition except in wet weather. The Beaver Creek Canyon and Bullhook roads are more important county roads in the Bear Paw Mountains. The rural roads are usually unimproved, and become very rutty and dusty during the late summer months when the grain traffic is heavy.

STATE LANDS

There are 117,500 acres of state land in Hill County, all of which is school land except 3,500 acres. The sale or lease of these lands is under the direction of the Registrar of State Lands, located in the capitol building at Helena. A minimum price of $10 per acre has been set upon these lands by legislative enactment.

ROCKY BOY INDIAN RESERVATION

The Rocky Boy Indian Reservation, established on the Fort Assinniboine military reservation in 1911, covers approximately two townships in the southeastern part of the county. The reservation lies in the Bear Paw Mountains and consists largely of rough, broken land which is suitable only for grazing. The Indians confined to the reservation have a mixed origin and number about 100.

CLIMATE

The climate of north-central Montana is characterized by a moderately low rainfall, a dry atmosphere, hot summers, cold winters, and a large proportion of sunny days. The midsummer temperatures are not oppressive because of the low humidity, and the winter extremes are usually not especially severe, as the cold waves are not always accompanied by high winds.

Tables 1 and 2 give the normal, monthly, seasonal, and annual precipitation and temperature at Havre, Clear Creek, and Chester. Havre, located in Milk River Valley, has the longest weather record in north-central Montana, dating from 1880. Clear Creek, located across the Hill–Blaine County line in the Bear Paw Mountains at an elevation of 3,300 feet, has an incomplete record between 1903 and 1920. Chester, located in Liberty County to the west, has a short record between 1900 and 1920.

TABLE 1.—PRECIPITATION

Months	Mean			Total amount driest year			Total amount wettest year			Snow, average in inches		
	Havre 1880-1920	Clear Creek 1905-1921	Chester 1900-1921	Havre 1905	Clear Creek 1918	Chester 1901	Havre 1884	Clear Creek 1911	Chester 1907	Havre	Clear Creek	Chester
December	0.63	0.76	0.34	0.12	0.08	0.60	0.72	0.50	0.02	5.7	9.1	3.3
January	0.69	1.06	0.60	0.85	1.08	0.60	0.16	1.45	1.50	7.9	14.1	5.6
February	0.47	0.57	0.26	0.14	0.44	T	0.44	1.45	0.50	5.4	6.1	3.1
Winter	**1.79**	**2.39**	**1.20**	**1.11**	**1.60**	**1.20**	**1.32**	**3.40**	**2.02**	**19.0**	**29.3**	**12.0**
March	0.48	0.54	0.34	0.15	0.16	0.10	0.53	0.56	0.40	5.0	6.3	2.7
April	1.01	0.86	0.50	0.70	0.55	0.15	0.25	1.35	2.06	3.2	4.0	0.9
May	2.09	2.34	1.60	0.83	0.65	2.42	3.05	2.48	1.60	1.8	0	0.3
Spring	**3.58**	**3.74**	**2.14**	**1.68**	**1.36**	**2.67**	**3.83**	**4.39**	**4.06**	**10.0**	**10.3**	**3.9**
June	2.82	3.20	2.77	1.72	0.14	1.80	4.72	2.62	6.06	T	0	0
July	1.92	1.73	1.02	0.86	0.77	0.01	9.67	2.64	0.77	0	0	0
August	1.26	1.29	1.18	0.30	2.53	0.03	2.61	2.89	1.77	0	0	0
Summer	**6.00**	**6.22**	**4.97**	**2.88**	**3.44**	**1.84**	**17.00**	**8.15**	**8.50**	**T**	**0**	**0**
September	1.03	2.14	1.30	0.12	0.90	1.11	2.69	5.65	0.93	0.5	1.5	0.6
October	0.50	1.14	0.30	0.37	0.77	0.01	0.41	1.30	0	2.2	5.0	1.4
November	0.77	0.66	0.32	0.60	0.08	0.07	0.42	1.85	0.02	4.6	5.6	2.7
Fall	**2.30**	**3.94**	**1.92**	**1.09**	**1.75**	**1.19**	**3.52**	**8.80**	**0.95**	**7.3**	**12.1**	**4.7**
Year	**13.67**	**16.29**	**10.53**	**6.76**	**8.67**	**6.90**	**25.67**	**24.75**	**15.96**	**22.2**	**51.7**	**20.6**

TABLE 2.—TEMPERATURE

Months	Mean			Absolute Maximum			Absolute Minimum		
	Havre 1880-1920	Clear Creek 1905-1921	Chester 1900-1921	Havre	Clear Creek	Chester	Havre	Clear Creek	Chester
December	20.4	21.0	19.1	63	60	72	-35	-31	-42
January	12.9	15.2	9.7	61	61	55	-57	-37	-55
February	13.6	19.2	14.0	63	63	65	-45	-38	-44
Winter	**15.6**	**18.5**	**14.3**	**63**	**63**	**72**	**-57**	**-38**	**-55**
March	27.1	30.4	25.9	77	76	70	-26	-20	-36
April	43.7	44.0	41.8	94	90	88	- 4	- 5	- 5
May	53.4	51.0	51.0	96	94	92	20	10	17
Spring	**41.4**	**41.8**	**39.6**	**96**	**94**	**92**	**-26**	**-20**	**-36**
June	62.0	60.2	59.6	108	98	104	29	28	27
July	69.3	67.0	66.7	103	102	103	37	34	30
August	65.4	64.2	64.0	106	103	100	27	29	28
Summer	**65.6**	**63.8**	**63.4**	**108**	**103**	**104**	**27**	**28**	**27**
September	53.4	55.3	53.4	94	90	93	19	21	13
October	44.5	41.5	44.9	89	86	83	- 7	- 8	- 3
November	31.2	33.5	30.0	75	69	77	-30	-18	-33
Fall	**43.0**	**43.4**	**42.8**	**94**	**90**	**93**	**-30**	**-18**	**-33**
Year	**41.1**	**41.9**	**40.1**	**108**	**103**	**104**	**-57**	**-38**	**-55**

Precipitation.—The average annual precipitation received at Havre is 13.67 inches, and at Chester less than 11 inches. The lowest amounts recorded at Havre and Chester are 6.76 and 6.90 inches; and the highest, 25.67 and 15.96 inches, respectively. In the Bear Paw Mountains the average annual rainfall exceeds 16 inches, accord-

ing to the Clear Creek data. Over 70 per cent of the total rainfall is received between March first and September first. May and June are the months of greatest rainfall, each averaging between 2 and 3 inches. The rainfall of the summer months is characterized by its local distribution in small dashing showers. The fall and winter seasons are usually open, but occasionally the snowfall is heavy.

Temperature.—Havre has the reputation of being one of the colder places in the United States, but with its mean annual temperature of 41.1° F. it has a more equable climate than points lying in the same latitude several hundred miles to the east. Through the year the temperature extremes are great, ranging from –57° to 108°F. January is the coldest month with an average mean of 12.9° while July with 69.3° is the warmest. The average frost-free period dates from the middle of May to the middle of September, ranging between 120 and 130 days in different parts of the county. Late spring frosts rarely injure early seeded small grain, but early fall frosts may damage the more tender crops, such as corn.

Wind.—The plains of north-central Montana are subject to strong, persistent winds which are usually more severe during the early spring months. Chinooks, or warm winter winds, are common to this part of the state, so that snow rarely accumulates to any great depth at the lower elevations. Hot winds occur during dry seasons and have caused severe crop losses. Hailstorms are of local occurrence as in other parts of the state.

MAPS

The four maps accompanying this report show (1) the location and extent of the different soils, (2) the main physiographic and geographic features, (3) the location and percentage of each section under cultivation, and (4) the United States geological land classification, which shows the adaptation of the land to agriculture.

Soil map.—The soil map accompanying this report is based upon the properties found in the soils under field conditions and shows the relationship of the soils in different parts of the county. A soil section such as found in road cuts and coulees shows distinct layers or horizons which cannot be attributed to the origin or manner of deposition of the parent material. The number, arrangement, and stage of development of these layers are largely the result of the common soil-forming processes which have varied in intensity under the climatic conditions prevailing in the different localities. Their

physical properties, such as color, structure, thickness, and relative position, depend upon the length of time the soil material has been subject to weathering and many other influencing factors, such as topography, drainage, vegetation, etc. These layers are the means of dividing the soils into large groups known as "soil series," which are further divided into "soil types" on the basis of the variations in texture, or the proportion of sand, silt, and clay in the surface layers. The soils of each series have the same general profile, in which the number, arrangement, and general character of the layers are the same. Reconnoissance surveys deal primarily with the identification and isolation of the larger soil groups and less attention is given the soil type. On the soil map the types most prevalent in each series are shown as loams, sandy loams, etc., but each type may contain small tracts of heavier or lighter soils and in some cases small areas of other soil series. Physiographic features, such as mountains and bad lands, are shown separately and not included in any of the soil series.

Topographic map.—The chief physiographic and geographic features of the county are represented on the topographic map. The location and extent of physiographic features, such as mountains, lakes, and bad lands, and such geographic features as towns, post offices, railways, and the more important stream courses are shown on this map. The general relief of the land is divided into three phases or classes—(1) level, (2) rolling, and (3) sharply rolling, or land too steep or broken for cultivatoin.

Area under cultivation.—At the time of this survey a record of the approximate acreage under cultivation was made for the purpose of locating the more intensely cropped sections and studying the conditions under which certain sections appear to be more favorably adapted to agriculture than others. The approximate percentage of each section in crop, fallow, and tame pasture is shown on the map.

Land classification map.—The Sixteenth Legislative Assembly of the state of Montana provided for a classification of all lands in the state for taxation purposes. The manner of carrying out the provisions of the act was left to the county authorities. In 1916, the United States Geological Survey undertook a classification of the public lands in the western states for the purpose of designating those areas in which 640-acre homesteads could be taken up under the stock-raising act. The state and government classifications were based largely upon topographic and vegetative features and in no instance was any informa-

tion obtained in regard to the soil relationships occuring in any one county or between two or more counties.

The land classification map supplements the soil and topographic maps by showing the general adaptation of the land to agriculture. The agricultural land is classified as (1) farm land, (2) farm grazing land, and (3) grazing forage land; while the non-agricultural land is classified as (1) grazing land and (2) non-tillable grazing land. The non-agricultural land includes both soil and physiographic features. For example, heavy alkaline stream bottoms and stony and very sandy soil are shown as non-agricultural, as well as the mountains and also the sharply rolling land and breaks along streams. In Hill County, the Federal land classification included all of the land in two classes —grazing forage and non-tillable grazing land. The larger tracts of irrigated land and the area covered by the proposed Marias Irrigation Project also are shown on the land classification map.

DESCRIPTION OF SOILS

The soils of the northern part of the Great Plains are characterized by rather dark-colored surface soils and by gray carbonate zones, consisting chiefly of lime in the lower soil depths. In north-central Montana the soils have developed under a moderately low rainfall, great temperature extremes, and a short grass cover. In the mountainous sections the rainfall has been greater, the temperature lower and more uniform, while the vegetative cover consisted largely of timber and shrubs. The oldest agricultural soils in the area are found on the bench lands and on the high plateaus. The deposits of gravel and rock fragments on these high table-lands are supposed to have been laid down during late Tertiary times. Erosion has been active in the area and the drainage has been good except locally in the glaciated area.

The soil profiles in Hill County vary with the elevation, age of the soils, and locally with the drainage and erosion. In the mountains above 5500 feet in elevation, the surface soils are almost black, and the lime-free heavy subsoils are dull reddish brown. The bench lands about the mountains are in various stages of erosion and the lime-coated, stony subsoils often lie close to the surface. The younger soils of the drift-covered area are brown to dark brown with friable carbonate zones below 7 to 15 inches. The soils developed over sedimentary rocks are usually immature and are often without distinct soil horizons.

The soils developed over drift in the more intensely glaciated sections of Hill County are included in three soil series—Williams, Scobey and Joplin. The Williams series includes the darker-colored soils with carbonate zones below 15 inches; while the Joplin series includes the lighter colored soils, with the carbonate zone often within 7 to 10 inches of the surface. The Scobey series is intermediate in color and depth of the carbonate zone, between the Williams and Joplin series. In Hill County the soils composing the Scobey series are the most extensive. The members of the Williams series are found on the higher glaciated slopes of the Bear Paw Mountains and those of the Joplin series are confined to the extreme western part of the county.

Scab lands predominate in the northeastern part of the county and occur as isolated tracts on the more level prairies in other parts. Scab lands have developed in the more feebly glaciated sections which are often underlain at comparatively shallow depths with dark-colored, non-calcareous, marine shales. The land is characterized by depressed irregular bare spots, locally called "slick spots" and "blow outs." The bare spots range in depth from 1 to 3 inches on the heavier loams to 8 inches or more on the lighter soils and in some localities cover more than 50 per cent of the total surface of land. In north-central Montana slick spots are common on the more level phases of the drift-covered area, especially at the heads of drainage basins. The less scabby phases were not isolated and mapped unless more than 20 per cent of the total surface was occupied with slick spots. The soils of the scab lands are grouped in the Phillips series, which has developed over modified drift, and contain a fair amount of residual material derived from sedimentary non-calcareous shales and sandstones.

Glacial stream deposits occur as terraces in the pre-glacial valley of Missouri River and are grouped in the Cheyenne series. The soils developed over these stratified sandy gravelly deposits have brown surface soils and rather deep carbonate zones.

The soils of the mountainous sections are grouped in two series—Blaine and Belknap. The Blaine series, which is the most extensive, includes a group of dark-brown, deep stony loams found on the broken unglaciated mountain slopes. The members of the Belknap series are confined largely to small tracts within the mountains and were largely isolated because of their dull reddish color, imparted to them by the parent red sandstone and shales. The black soils at the higher moun-

tain elevations were not mapped separately but were included within the area map as rough broken land.

The soils developed over dark-colored non-calcareous shales are grouped on the basis of their maturity in three series—Lismas, Pierre, and Marias. The immature soils of the Lismas series, which are without distinct soil horizons, are confined to the shaly breaks of Marias River and because of their limited extent are included in the Pierre series in Hill County. The members of the Pierre series have a calcareous surface mulch and a faintly developed humus-bearing layer. Their lower depths are olive-brown clays, containing fragments of shale below 4 to 6 feet. The Marias series includes a group of fairly mature soils, which have well-developed calcareous surface mulches and humus-bearing layers. The subsoils are deep, dark-colored, plastic calcareous clays. The soils of the Pierre and Marias series cover small tracts along Marias River and in other parts of the county where dark-colored shales are exposed.

The soils developed over light-colored, calcareous sandstones and shales are represented in the county by the Bainville series. The soils of this series are immature and have developed shallow, light-brown, humus-bearing layers. The lower depths have the structure of the parent sandstones and shales, and are usually mottled with rusty brown streaks. The Bainville soils cover the sandstone breaks along Milk River, and the eroded slopes of such buttes as Signal Butte.

In the pre-glacial valley of Missouri River, the soils on the more scabby terraces which are underlain with loose sands and gravels were grouped under a separate series named Box Elder. The stratified stream deposits underlying these terraces are probably of pre-glacial origin. The greasewood alkali flats around Box Elder are also included in this series.

The Orman series includes a group of soils found in the poorly drained heavy depressions in the pre-glacial valley of Missouri River. These soils have well-developed, non-calcareous, humus-bearing layers and distinct carbonate zones below 5 to 7 inches.

The recent stream deposits and wash below the breaks of streams were included in the Laurel series. The Laurel group of soils is usually calcareous at the surface and has poorly developed humus-bearing layers. The lower depths are stratified sands, silts, and clays. In this group of soils are also included the bottoms of old glacial lake beds.

Table 3 gives the names and actual and relative extent of each soil mapped in the county. It also shows the topographic adaptation of each type to agriculture.

TABLE 3.—SOIL AND TOPOGRAPHY OF HILL COUNTY

Type	SOIL		TOPOGRAPHY			
			Level to sharply rolling		Sharply rolling	
	Total area in square miles	Percentage of county	Square miles	Percentage under cultivation	Square miles	Percentage under cultivation
Scobey loam	1318.7	40.6	1174.1	20.4	144.6	0.1
Scobey sandy loam	239.4	8.3	239.4	15.3	—	—
Scobey stony loam	59.4	2.0	55.3	0.1	4.1	0.0
Joplin loam	111.8	3.9	110.8	14.9	1.0	0.0
Joplin silt loam	54.1	1.9	54.1	6.7	—	—
Joplin clay loam	4.5	0.2	4.5	4.4	—	—
Joplin stony loam	2.0	0.1	2.0	—	—	—
Williams loam	5.3	0.7	3.8	40.0	1.5	0.0
Phillips loam	640.3	22.1	640.3	10.6	—	—
Bainville loam	74.6	2.6	3.6	7.0	71.0	0.0
Pierre clay loam	14.6	0.4	3.7	0.0	10.9	0.0
Marias clay loam	3.1	0.1	3.1	14.5	—	—
Blaine loam	113.9	3.9	12.6	13.1	101.3	1.8
Box Elder loam	16.5	0.5	16.5	9.9	—	—
Cheyenne gravelly loam	12.8	0.4	12.8	14.8	—	—
Orman clay loam	6.3	0.2	6.3	14.2	—	—
Laurel loam	78.1	2.7	78.1	4.0	—	—
Laurel clay loam	32.9	1.1	32.9	0.0	—	—
Badlands	11.0	0.4	—	—	—	—
Mountains	107.6	3.7	—	—	—	—
Lakes	4.7	0.2	—	—	—	—

SCOBEY LOAMS

Description.—The lighter-colored phase of the Scobey loams, such as is found in the central part of the county, has 2 to 3 inches of loose, light grayish-brown, fine sandy mulch on the surface. The humus-bearing layer is a non-calcareous, brown, crumbly loam averaging 5 to 7 inches thick. The subsurface layer is a light-brown, compact, columnar-structured loam, having a slightly heavier texture. The carbonate zone below 8 to 15 inches is a gray, compact, silt loam grading into yellowish-brown drift at 36 to 42 inches. In the vicinity of Simpson the subsoils are locally stratified fine sandy loams, with a distinct yellowish cast. In the south-central part of the county the surface soils often grade into sandy loams, underlain locally with rather heavy subsoils.

The darker-colored phase of the Scobey loams, such as is found on the slopes of the Bear Paw Mountains, has a loose,brown, organic,

sandy mulch on the surface at the higher elevations. The humus-bearing layer is a dark-brown friable loam averaging 7 inches thick. The subsurface layer is a brown,compact, columnar-structured, heavier-textured loam. The carbonate zone below 10 to 24 inches is a grayish-brown silt to silty clay loam, grading into yellowish-brown, loamy drift at 4 feet or more. In the northwestern part of the county the soils about King, Goldstone, and Fairchild post offices are rather dark-colored loams. The surface mulch is well developed and the brown humus-bearing layer averages 5 inches thick. The zone of lime accumulation lies 10 to 14 inches below the surface and often grades into sandy drift at 30 inches or more. The soils of the depressions in this part of the county are usually scabby silt loams.

The heavier phase of the Scobey loams, such as is found in the west-central part and in the vicinity of the scab lands in the northeastern part of the county, has a dull grayish-brown, granular, silty mulch on the surface. The brown humus-bearing layer averages about 5 inches thick. The subsurface layer is rather shallow and very compact. The carbonate zone below 9 to 12 inches grades into silty to very fine sandy drift at 30 inches or more.

Soils developed over drift are quite variable in texture and are rarely uniform over large areas. In a more detailed survey fair-sized tracts of very fine sandy loams would be shown on the soil map in the central and southern parts of the county. Glacial boulders are sufficiently numerous in most sections to preclude farming before the land is cleared. The more stony and gravelly phases are found (1) in the north-central part of the county, (2) south of Milk River in the vicinity of Chain Lakes and Kremlin, (3) along the upper course of Sage Creek, and (4) on the slopes of the Bear Paw Mountains.

Topography.—Scobey loams cover the greater part of the rolling plains of Hill County and extend well up the slopes of the Bear Paw Mountains. The land has a rolling billowy relief, with other typical glacial features, such as low mounds, stony ridges, and lake depressions. The more broken phases occur (1) on the slopes of the Bear Paw Mountains, (2) on the divide east of Milk River, and (3) locally above the breaks of some of the streams. The Scobey loams have good drainage except on some of the broader divides.

Tillable area.—Scobey loams cover 1318 square miles, or almost one-half of the total area of the county, of which 82 per cent is suitable for farming. On the land classification map prepared by the United States Geological Survey 89 per cent of the area is classi-

fied as grazing forage land and the remainder as non-tillable grazing land.

Utilization.—Scobey loams were homesteaded in tracts of 160 acres between 1910 and 1912 and largely broken out before 1915. During the dry years between 1917 and 1921, the cropped acreage was greatly reduced and a large acreage abandoned. In 1924 approximately 20 per cent of the tillable land was under cultivation. The cropped acreage was well distributed but confined largely to the west-central part of the county within 6 to 8 miles of the main line of the Great Northern Railway. In the southern tier of townships in the south-central part, the more broken land along the streams and the more scabby soil phases were not extensively cultivated.

Exclusive grain growing has been largely practiced on the Scobey loams since the land was broken, although since the drought stock raising is often combined with grain growing in the less desirable farming districts. The farms are large, usually covering more than one section of land. The annual cropped acreage on many of these farms is between 200 and 600 acres or more. Spring wheat is the most important cash crop grown in the area. Flax also is an important cash crop on new breaking. Other small grains, such as oats, barley, and rye, are grown chiefly for feed and forage. Fall wheat winter-kills too frequently in the lower plains to be depended upon and the acreage is confined largely to the dark-colored soils on the slopes of the Bear Paw Mountains. The corn acreage, which was rather small in 1924, is confined largely to the central and south-central parts of the county. Forage crops, such as alfalfa, sweet clover, and brome grass, covered a very small acreage in 1924. Continuous cropping to small grains is generally carried on until the land becomes foul, when a clean summer fallow is introduced every second or third year. The Scobey loams drift after the root fiber has been destroyed, and over the greater part of the county clean summer fallow is usually introduced every third year, the second crop being stubbled in. Duckfoot cultivators and similar implements, which reduce the cost of production and are efficient in controlling weeds and soil drifting, are commonly employed in preparing the land for spring seeding and for summer fallow. The motive power on the large grain farms consists chiefly of tractors and large horse outfits. The number of small combine-harvesters has increased rapidly during the past few years.

Scobey loams are the most important agricultural soils in Hill County. The soils are easily maintained in good tilth and have a good

water-holding capacity. The surface acre-foot contains from 2310 to 4480 pounds of nitrogen, 980 to 2980 pounds of phosphorus, and 7000 to over 12,000 pounds of calcium. The average nitrogen content of the plains soils is between 3000 and 3500 pounds, and on the mountain slopes above 3500 pounds. The average phosphorus content is between 1200 and 1500 pounds, except where the drift is modified with sedimentary material. The soils are well supplied with free lime. The yields of spring wheat depend upon the amount and distribution of the seasonal rainfall and the cultural method. The average yields have been low, probably not exceeding 10 bushels per acre since the land was broken. Farmers expect spring wheat to average between 15 and 20 bushels per acre on well-prepared summer-fallowed land in favorable seasons.

Improved land is held at $20 to $25 per acre, while unimproved agricultural land is valued at $10 to $20 per acre. The value of grazing land depends upon its location, carrying capacity for live stock, and water-holes, but it is usually priced very low.

Vegetation.—The principal cover on the Scobey loams is grama grass (*Bouteloua gracilis*) and its associated species. The black-rooted sedge known as nigger wool (*Carex filifolia*) is usually associated with grama on the more droughty soils. Other grasses, such as needle grass (*Stipa comata*) and June grass (*Koeleria cristata*) are the dominant types, where the cover has been disturbed. All the grasses are considered excellent range forage.

Mountain sage (*Artemisia frigida*) and gum weed (*Grindelia squarrosa*) are the more common shrubs. Black sage (*Artemisia tridentata*) and western wheat grass (*Agropyron smithii*) occur on the heavier phases in the vicinity of shale outcrops. None of the shrubs is important range forage, although mountain sage is readily eaten by sheep. Native trees and large shrubs are not found on the glaciated plains except where transplanted.

Grass cover is heaviest on the mountain slopes and lightest in the vicinity of the scabby tracts. It would require 25 to 30 acres to carry a 1000-pound steer through a grazing season of 10 to 12 months in the central part of the county; while 30 to 35 acres would probably not be too large in the extreme western, southern, and northeastern parts. On the slopes of the mountains 20 acres would be sufficient in average seasons.

The land broken at the time of settlement and later abandoned during the dry years has been very slow to grass over. Some of the

fields abandoned in 1919 are still producing "Jim Hill" mustard and Russian thistles. On the older tracts needle grass, June grass, western wheat grass, and mountain sage are obtaining a foothold in the more moist basins. It is claimed on good authority that grama grass will not become established for a period of 35 to 50 years. Russian thistles make a fair range forage before the spines become too hard.

SCOBEY SANDY LOAMS

Description.—The surface 2 to 3 inches of the Scobey fine sandy loams in the central part of the county, west of Kremlin, is a loose, grayish-brown, sandy mulch, which develops a compact laminated structure in wet seasons. The humus-bearing layer is a brown, friable, fine sandy loam averaging 5 inches thick. The subsurface layer is a light-brown, compact, faintly columnar-structured, sandy loam. The carbonate zone below 18 inches is a gray, compact, sandy loam grading into loose, sandy, gravelly, yellowish-brown drift at 3 or 4 feet. The fine sandy loams in the depression running northwest from Miller and Simpson post office also have well developed sandy mulches on the surface. The humus-bearing layer averages 7 inches thick, and the subsoils below 3 to 4 feet grade into stratified yellowish sands and gravels.

The coarse sandy loams, such as are found south of Wild Horse Lake and locally on the sandy tracts north and south of Gildford, have a loose sandy mulch on the surface. The humus layer is a light-brown, coarse, sandy loam averaging 7 inches thick. The subsurface layer is compact and often reddish brown in color. The carbonate zone lies 18 to 24 inches below the surface and grades into loose sands with depth.

Scobey sandy loams are rather variable in texture, ranging from fine sandy loams to loose coarse sands. Boulders are not usually abundant on the sandy loams, but the low hillocks and ridges are often very gravelly.

Topography.—Scobey sandy loams are distributed over the drift-covered area of the county. The larger tracts are found along Sage Creek in the central and southern parts and south of Wild Horse Lake in the north-central part. The fine sandy loams have a rolling relief, while locally the coarse sandy loams have a sand dune topography. Scobey sandy loams have good drainage, although the intermittent stream bottoms are often alkaline.

Tillable area.—Scobey sandy loams cover 239 square miles, or 8 per cent of the county. About 18 per cent of the more sandy phases is included in the non-tillable grazing class on the land classification map.

Utilization.—The Scobey sandy loams were settled and broken at the same time the Scobey loams were placed under cultivation. The more sandy tracts were abandoned during the dry years and are largely utilized for the grazing of live stock. In 1924, 15 per cent of the tillable land was under cultivation. The cropped acreage was largely confined to the fine sandy loams west of Kremlin and to the sandy basin in the north-central part of the county. The type of farming practiced on the Scobey sandy loams is somewhat more diversified than on the Scobey loams. More stock is found on the farms and a greater acreage is in corn and forage crops. Spring wheat is the main cash crop and continuous cropping to small grains is generally practiced. However, the soils are likely to drift after the root fiber has been destroyed.

The fine sandy loams are among the better agricultural soils in Hill County. The soils are open and porous and have only a fair water-holding capacity. The surface acre-foot contains 2000 to 3500 pounds of nitrogen, 1190 to 1575 pounds of phosphorus, and 600 to 10,000 pounds of calcium. These soils are lower in nitrogen by 500 pounds or more per acre than the Scobey loams and their fertility will probably decline more rapidly. As the root fiber is destroyed by cultivation, the soil will probably drift. Crop yields on the fine sandy loams compare favorably with those on the loams.

Vegetation.—The grass cover on the Scobey fine sandy loams consists chiefly of grama grass, nigger wool, and sand grass (*Calamovilfa longifolia*). On the coarse sandy loams the tall grasses often predominate. Needle grass and June grass form the chief cover in the over-grazed sections. In addition to the shrubs found on the Scobey loams, valley sage (*Artemisia cana*) covers small patches. The grass cover on the coarse sandy loams is somewhat lighter than on the fine sandy loams. The live-stock carrying capacity of the sandy loams ranges between 25 and 35 acres per head.

SCOBEY STONY LOAMS

The profiles of the Scobey stony loams are in general similar to those on the Scobey loams and sandy loams found in the vicinity of the stony tracts, except for a greater content of stone and gravel on

the surface and in the soil. The surface soils on the tops of the mounds and ridges are usually shallow and fairly deep around the pot-holes and depressions. Rather dark-colored, stony loams are found on the slopes of the Bear Paw Mountains and in the northwestern part of the county.

Topography.—Scobey stony loams occur as isolated tracts. They are somewhat more numerous along the upper courses of Sage Creek and Milk River and in the extreme east-central part of the county. Most of the stony tracts consists of low stony mounds and ridges.

Tillable area.—Scobey stony loams cover 59 square miles, about 8 per cent of which is too broken for cultivation. On the land classification map 57 per cent of the area is classified as non-tillable grazing land.

Utilization.—Scobey stony loams are in general too stony for cultivation and are utilized chiefly for grazing. Less than 1 per cent of the tillable land was in crops in 1924. The Scobey stony loams contain about the same amount of plant food in the surface acre-foot as the Scobey loams. The yields of small grains on the land brought under cultivation are about the same as on the loams.

Vegetation.—The grass and shrub cover on the Scobey stony loams does not differ greatly from that on the loams and the carrying capacity for live stock is about the same.

JOPLIN LOAMS

Description.—The surface 1 to 2 inches of the Joplin loams in Hill County is a dull, light grayish-brown, loose to granular, fine sandy silty mulch. The humus-bearing layer is a dull-brown, cloddy, columnar-structured loam, averaging 3 to 5 inches thick. The columnar-structured, light-brown subsurface layer is very compact and somewhat heavier in texture. The carbonate zone below 8 to 11 inches is a compact, feebly columnar-structured loam to silt loam grading into dull yellowish-brown, structureless drift at 30 or more inches. The lime is uniformly distributed through the upper part of the layer but in the lower part often occurs in streaks and blotches. In the northwestern part of the county fragments of yellow sandstones occur in the parent drift and in the southern part there are fragments of shale. The better developed soils are found on the broad divides along O'Brien Coulee.

Topography.—Joplin loams occur as two separate tracts in the extreme western part of the county between Sage Creek and Black

Coulee. The land has a typical glacial relief, consisting of long billowy slopes on the rolling divides. The more hilly land is found along Tootsie and O'Brien coulees. Drainage has not been developed on the tracts.

Tillable area.—Joplin loams cover 112 square miles, of which 34 per cent is too rolling and broken for cultivation. On the land classification map only a narrow strip along Tootsie Creek is classified as non-tillable grazing land.

Utilization.—Joplin loams were settled and broken during the so-called dry-land movement. Most of the tillable land was under cultivation before the time of the drought. In 1924, 15 per cent of the land suitable for farming was in crops. The cropped acreage was largely confined to the broad divides along Tootsie Creek. The cropping and tillage methods are the same as on the Scobey loams. The land under cultivation is devoted chiefly to spring wheat and the unimproved and abandoned land to the grazing of live stock.

Joplin loams are under cultivation in Hill County. The soils are not difficult to maintain in good tilth and have a good water-holding capacity. The surface acre-foot contains from 3600 to 4600 pounds of nitrogen, 1575 to 1645 pounds of phosphorus, and from 11,000 to 20,000 pounds of calcium. The yields of spring wheat have averaged about the same as on the Scobey loams. Soil drifting is rather serious on the Joplin loams and in dry springs some damage is done to early seeded small grains.

Vegetation.—The plant relationships on the Joplin loams are the same as on the Scobey loams. Mountain sage is more abundant and prickly pear more conspicuous on the heavier phases. The grass cover is somewhat lighter than on the Scobey loams and a few more acres would be required to graze a steer through the season.

JOPLIN SILT LOAMS

Description.—Joplin silt loams have well-developed, dull, slaty, granular silty mulches on the surface, which develops a distinct laminated structure in wet seasons. The humus-bearing layer is a compact, columnar-structured, dull-brown, cloddy silt loam, averaging 3 to 5 inches thick. The subsurface layer is slightly heavier in texture and very compact. The lower part of the layer is slightly calcareous and the clods are usually stained with organic matter. The carbonate zone averages from 5 inches below the surface in the basin above Marias River to about 11 inches on the lower slopes of the divide

south of Black Coulee. It is a grayish-brown, compact, structureless silt loam containing pockets of alkaline material in the lower part. The carbonate zone is not as well defined as in the loams and the lime occurs chiefly in streaks and blotches. The parent drift below 24 to 30 inches is a massive, yellowish-brown, rather friable silt loam.

Joplin silt loams have developed over a glacial stream or lake deposit, which is 30 to 40 feet thick in the basin above Marias River and overlies dark-colored shales. The deposit is stratified and contains fragments of shale. Some gravel occurs on the surface and in the soil, but is not very abundant. A few boulders are found on the surface of the heavy loams on the lower slopes of Black Coulee.

Topography and utilization.—Joplin silt loams cover the greater part of the basin above Marias River in the southwestern corner of the county. The land has a level relief between the deeply intrenched coulees. It covers 54 square miles, of which 8 per cent is classified as non-tillable grazing land on the land classification map.

The Joplin silt loams lie some distance from railways and were not so well settled and broken out during the dry-land movement as some of the more favorably located soils. The soils are rather retractive, but have a good water-holding capacity. The surface acre-foot contains 3000 to 3500 pounds of nitrogen, 1200 to 1500 pounds of phosphorus, and 10,000 to 20,000 pounds of calcium. In 1924, 7 per cent of the land was in crops. It was confined largely to the deeper silt loams in the vicinity of Brinkman. The yields of spring wheat average about the same as on the Joplin loams. The unimproved land is largely utilized for grazing.

Vegetation.—Grama grass, mountain sage, western wheat grass, and prickly pear predominate on the Joplin silt loams. The land has a light grass cover, 35 to 45 acres being required to support a steer through the grazing season.

JOPLIN CLAY LOAMS

Description.—The surface 1 to 2 inches of the Joplin clay loams is a dull grayish-brown, granular silty clay mulch. The humus-bearing layer is a cloddy, dull, compact, platy-structured, plastic silty clay, averaging 5 to 7 inches thick, and effervescing weakly with acid. The subsurface layer is not developed, and below 6 to 7 inches the subsoil is a compact, cloddy, calcareous, grayish-brown, silty clay to clay loam. The lime occurs chiefly in streaks and blotches, and alkali flecks the heavy material below 12 to 15 inches. The parent material

below 30 inches is a dull olive-brown massive silty clay. Boulders are not numerous on the surface, but a small amount of gravel is found in ing capacity of the heavy loams is low, averaging between 40 and 45 the mulch.

Topography.—Several small tracts of Joplin clay loams occur in the basin above Marias River. The land has an undulating relief. The heavy loams cover 4.5 square miles, all of which is classified as non-tillable grazing land. The soils contain in the surface foot 3000 to 4000 pounds of nitrogen, 1500 pounds of phosphorus, and exceptionally large amounts of calcium. The Joplin clay loams are too retractive for farming under dry-land conditions and are utilized for grazing.

Vegetation.—Joplin clay loams have a light covering of grama grass, western wheat grass, and prickly pear. The live-stock carrying capacity of the heavy loams is low, averaging betwen 40 and 45 acres per head in normal seasons.

JOPLIN STONY LOAMS

Description.—The profiles of the Joplin stony loams are in general the same as for the Joplin loams, except for the greater quantity of rock and gravel on the surface and in the soils. The surface soils are rather shallow on the tops of the mounds and ridges.

Topography and utilization.—Joplin stony loams are distributed over the extreme west-central part of the county, south of O'Brien Coulee, covering an area of 2 square miles, of which one-half is classified as non-tillable grazing land on the land classification map. The stony loams are used chiefly for grazing.

Vegetation.—The Joplin stony loams are well grassed with grama grass and its associated species. The live-stock carrying capacity of the stony loams is about the same as for the Joplin loams.

WILLIAMS LOAMS

Description.—The surface 1 to 2 inches of the Williams loams is a fibrous mat of organic matter derived from a creeping moss. Below the moss, the surface 5 inches is a very dark-brown, almost black, friable loam, grading locally into a sandy loam. The upper part of the subsurface layer, averaging 5 to 10 inches thick, is a columnar-structured, rather compact, brown loam grading into a lighter brown, more compact, and heavier-textured loam in the lower part. The carbonate zone below 16 inches is a grayish-brown, compact silt to silty clay loam. The parent drift below 3 to 4 feet or more is a light-brown,

structureless, compact loam. Boulders and gravel occur on the surface and in the soil in varying amounts.

Williams loams grade into the Scobey loams on the lower slopes of the mountains without an abrupt change in the character of the soil horizons or in the relief of the land. On the higher mountain slopes, the transition between the Williams loams and Blaine stony loams is marked by a greater content of rock fragments on the surface and outcrops of trap rock.

Topography and utilization.—Williams loams occur on the western slopes of the Bear Paw Mountains in the southeastern part of the county. The tillable land is confined largely to slopes and bottoms of the basins of the larger streams. Williams loams cover 5 square miles, about one-half of which is classified as non-tillable grazing land on the land classification map.

Williams loams are utilized chiefly for grazing. In 1924 less than 10 per cent of the tillable land was under cultivation. The cropped land was found largely on the Rocky Boy Indian Reservation and devoted chiefly to the growing of forage crops. Outside of the reservation a small acreage was in fall wheat. The Williams loams in Hill County, while well supplied with plant food, are too high in elevation to successfully mature most of the crops grown in the lower plains.

Vegetation.—The grass cover on the Williams loams consists chiefly of grama grass and its associated species, but at the higher elevations grama grass gives way to a mountainous type, consisting of the tall grass and shrubs. Selaginella, a low creeping moss without any feeding value, is quite noticeable on the surface of the loams in Hill County. The carrying capacity of the Williams loams is between 15 and 20 acres per head of cattle.

PHILLIPS LOAMS

Description.—Phillips loams are characterized by numerous depressed bare spots locally called "slick spots" and "blow outs." The character of the bare spots varies with the texture and probably with the stage of development. On the heavier phases bare spots cover from 20 to 40 per cent of the total surface of the land. Bare spots are also widely distributed over the soils of the Scobey and Joplin series, especially at the heads of drainage basins, but the scabby lands were not mapped unless more than 20 per cent of the surface of the land was covered by these spots.

The grassed over portion of the heavier phases of the Phillips loams, such as are found in the northeastern part of the county, has a loose, granular, deep silty to fine sandy mulch on the surface. The humus-bearing layer is a compact, columnar-structured, brown silt to silty clay loam averaging 5 inches thick. The subsurface layer is often poorly defined and at depths of 7 to 13 inches grades into a compact, gray, heavier-textured, carbonate zone. Below 20 inches the lower depths are stratified compact silty clays, streaked with lime.

The bare spots are depressed 3 to 5 inches and have a glazed crust on the surface in which gravel is conspicuously imbedded. The surface one-fourth inch is a light-gray, friable, silty crust, underlain with a honey-combed or vascular-structured layer grading into a compact, impervious hardpan having the texture of a clay loam. Thin layers of black organic matter are found in the hardpan at depths of 3 to 4 inches. The sandy carbonate zone below 4 inches is similar to that found under the grassed over portion, except that it is more flecked and blotched with lime and alkali. The lower soil depths are stratified silty clays.

In the central and western parts of the county the profiles of the grased over portion of the Phillips loams are similar to those found in the Scobey and Joplin loams and sandy loams, except for a more pronounced surface mulch and a more compact subsurface layer. On the loams the bare spots are depressed 5 to 7 inches and the silt to silty clay impervious hardpan averages 4 to 5 inches thick. The lower part of the hardpan is flecked with lime and alkali. On the sandy loams, such as are found in the north-central and northwestern parts of the county, the bare spots are depressed 8 to 12 inches, and usually below the honey-combed layer is a compact, sandy layer grading into an impervious, gritty, silty hardpan. The lower soil depths are the same as are found under the grassed over portion.

Topography.—Phillips loams are distributed over the more level and undulating phases of the glaciated plains of Hill County, the larger bodies being located in the northeastern and northwestern parts. Low, stony, gravelly hummocks are somewhat more conspicuous on the Phillips loams than on the Scobey and Joplin loams.

Tillable area.—Phillips loams cover 640 square miles, or 22 per cent of the total area of the county. On the land classification map 18 per cent of the area is classed as untillable grazing land, which consists largely of old glacial lake beds.

Utilization.—Phillips loams were fairly well settled and broken out before the time of the drought, but during the dry years a very large acreage was abandoned and has not been reclaimed. In 1924, 10 per cent of the tillable land was under cultivation. The improved land was found largely on the less scabby phases, where bare spots covered less than 30 to 35 per cent of the total surface of the land. Spring wheat is the most important crop grown on the scabby loams. The cropping and tillage methods are the same as on the Scobey loams. The land not under cultivation is used for the grazing of live stock.

The soils in the slick spots are rather retractive. In dry seasons satisfactory stands of small grains are difficult to obtain on these spots, and the grain that does make a catch is usually stunted and the first to shown signs of firing, although water may have stood in the depressions for several weeks in the spring. In wet seasons the growth is more favorable. The surface acre-foot of the grassed over sections contains from 3000 to 4000 pounds of nitrogen, 1260 to 2065 pounds of phosphorus, and 6300 to 20,000 pounds or more of calcium. The soils of the bare spots average a few hundred pounds lower in nitrogen and often contain 30,000 to 60,000 pounds of calcium. Crop yields have varied greatly on the Phillips loams, but average lower than on the Scobey loams.

Vegetation.—The plant relationships on the grassed over portion of the Phillips loams are the same as on the Scobey and Joplin loams. Annual weeds and shrubs are somewhat more abundant and prickly pear is prevalent on the heavier phases. The live-stock carrying capacity of the scabby loams is variable, but on an average 35 to 40 acres would support a steer through the grazing season. The Phillips loams are considered better adapted to the grazing of sheep than cattle during the spring and early summer months when the water-holes are filled.

BAINVILLE LOAMS

Description.—The Bainville loams such as are found on the slopes of Signal Butte have a shallow, gray, calcareous, sandy mulch on the surface. The humus-bearing layer, which is not well developed, is a compact, gray to yellowish-brown, silt to sandy loam, averaging 3 to 4 inches thick. The subsoils are gray to yellowish silt and sandy loams having the structure of the parent material, and usually mottled with rusty iron streaks. Fragments of the parent sandstones and shales are usually found in the lower depths.

The Bainville loams such as are found along the Milk River consist largely of grayish-brown, calcareous, silty to fine sandy colluvial material. The humus-bearing layer is very shallow and grades into unmodified colluvial material or shales and sandstones underlying the wash at various depths. Boulders often occur on the tops of the breaks and locally on the colluvial slopes.

Topography and utilization.—Bainville loams cover the breaks along Milk River and the broken slopes of Signal and other buttes. The loams cover 71 square miles, of which 80 per cent is classed as non-tillable grazing land on the land classification map. The type is not under cultivation and is used chiefly for the grazing of live stock.

Vegetation.—Grama grass and nigger wool form the principal cover on the Bainville loams. The density of the grass cover is light and 40 acres would be required to carry a steer through the grazing season.

PIERRE CLAY LOAMS

Description.—Pierre clay loams have a loose, granular, slightly calcareous, grayish-cast, silty clay mulch on the surface averaging 2 inches thick. The poorly developed humus-bearing layer is a compact, dull-brown, plastic clay loam, grading into faintly calcareous, platy-structured, olive-brown clays. The lower soil depths are mottled with pockets of rusty brown material, and at 15 to 18 inches are flecked with white ashy alkaline material. Fragments of the parent shale are found below 3 feet. Wide cracks penetrate the soil for 10 to 15 inches below the mulch.

Topography and utilization.—Pierre clay loams cover the broken slopes of Goosebill Dome south of Marias River and also the eroded breaks of Box Elder Creek in the east-central part of the county. The heavy loams cover 14.5 square miles, of which 59 per cent is classified as non-tillable grazing land. The type is not under cultivation and is used for grazing of live stock.

Vegetation.—The Pierre clay loams are lightly grassed over. Grama grass and western wheat grass form the principal cover. Grama grass does not form a continuous cover but occurs largely in patches. Black sage, and the annual shrubs and weeds form the principal cover in the more barren sections. The carrying capacity of the Pierre clay loams is low.

MARIAS CLAY LOAMS

Description.—The surface 2 to 3 inches of the Marias clay loams is a gray, granular, silty clay mulch, effervescing freely with acid.

The calcareous humus-bearing layer is a cloddy, grayish-brown, compact, plastic clay loam. The subsoil below 8 to 10 inches is a grayish, olive-brown, compact, plastic clay, effervescing freely with acid. Pockets of gray, ashy, alkaline material occur in the subsoils at depths of 15 inches or more, and the clods have a glazed surface.

Topography and utilization.—Marias clay loams cover small tracts in the basin above Marias River totalling 3 square miles, all of which is classed as grazing forage land. The Marias clay loams are among the more productive soils in north-central Montana, but because of their location in Hill County are used chiefly for grazing. These soils have a high water-holding capacity and are rather retractive in wet seasons. The surface acre-foot is well supplied with the mineral plant foods. In 1924, 10 per cent of the heavy loams was under cultivation. The soils are very plastic and are usually prepared for spring seeding in the fall with disk and slat moldboard plows. Spring wheat grown on well-prepared summer fallow often yields higher than on the Scobey loams in favorable seasons.

Vegetation.—Western wheat grass and black sage form the principal cover on the Marias clay loams, with grama grass and prickly pear occurring chiefly in patches. The carrying capacity of the Marias clay loams is low, but somewhat higher than that of the Joplin clay loams.

BLAINE STONY LOAMS

Description.—Blaine stony loams have a shallow, dark-colored, organic mulch on the surface. The humus-bearing layer is dark-brown, almost black, friable, stony loam averaging 6 inches thick. The subsurface layer is a faintly blocky-structured, compact silt to silty clay loam, ranging in color from a reddish brown in the upper part to a brown in the lower part. The carbonate zone below 30 inches is a compact, structureless silt to silty clay loam grading into more friable, silty stony material with depth.

The Blaine loams covering the buttes below the mountains are modified with drift. In the mountains small tracts of soils with distinct reddish colors were isolated as Belknap loams, but because of the small area are included in the Blaine loams and are not shown separately on the soil map.

Topography and utilization.—Blaine stony loams cover the broken slopes of the Bear Paw Mountains above the glaciated area. They cover 114 square miles, of which less than 2 per cent is shown on the

land classification map as grazing forage land. The land under cultivation is confined to small tracts along the larger streams and devoted largely to forage crops, to supplement the winter grazing lands.

Vegetation.—A mountainous type of vegetation, consisting chiefly of the tall grass and shrubs, covers the Blaine stony loams. The tall grasses are not considered so nutritious as the short grasses for stock, but are a fair range forage for sheep and goats. The higher mountain slopes are covered with snow for several months in the year.

BOX ELDER AND UNDIFFERENTIATED LOAMS

Description.—The surface of the Box Elder loams has the appearance of the Phillips loams. The bare spots on the lighter loams around Laredo are depressed 6 to 10 inches and cover 40 per cent of the total surface of the land. On the heavier loams north and west of Box Elder the bare spots are not depressed as deeply, but cover a greater portion of the land.

The surface 2 inches of the grassed over portion of the lighter loams is a light grayish-brown, loose, fine, sandy mulch. The humus-bearing layer is a brown, compact, fine, sandy loam averaging 4 to 8 inches thick. The columnar-structured subsurface layer is a compact, slightly heavier-textured, light-brown, sandy loam. The carbonate zone below 6 to 12 inches is a compact, structureless, sandy loam grading into stratified loose sands and gravels at 40 inches or more.

The bare spots have a gray silty crust on the surface below which the silty material is slightly honey-combed. The hardpan is a compact, non-calcareous, impervious, brown silt loam, flecked with white, ashy, alkaline materials and averaging 2 to 3 inches thick. The hardpan is underlain with a compact, yellowish-brown, fine, sandy loam for 16 inches, before grading into loose, stratified sands and gravels.

The heavier phases south of Laredo are more barren, scabby, silty clays, underlain with heavy subsoils. The bare spots are rather shallow.

The greasewood flats south of the mouth of Sage Creek were undifferentiated. The soils of these flats are dark-colored massive clays, highly impregnated with alkali.

Topography and utilization.—Box Elder loams occur in the southern part of the pre-glacial valley of the Missouri River along Big Sandy Creek. The scabby loams are several feet above the flood plains of the creek. The greasewood flats are hummocky due to the accumulation of wind-blown material about the shrubs. The loams

cover 16.5 square miles, all of which is classified as grazing forage land on the land classification map. The lighter-textured phase around Laredo was under cultivation before the drought, but since that time has been abandoned and is largely utilized for the grazing of live stock. The heavier phase around Big Sandy is partly under irrigation. In 1924, 10 per cent of the Box Elder loams was in irrigated crops, consisting chiefly of alfalfa.

Vegetation.—Grama grass forms the chief cover on the Box Elder loams. Greasewood and other shrubs adapted to alkaline conditions predominate on the heavy alkali flats. The live-stock carrying capacity of the better grassed over sections is betwen 30 and 35 acres per head.

CHEYENNE GRAVELLY LOAMS

Description.—The surface 2 inches of the Cheyenne gravelly loams is a light grayish-brown, loose, sandy mulch. The humus-bearing layer is a rather shallow, friable, sandy loam to coarse sandy loam. The faintly columnar-structured subsurface layer is compact, and slightly heavier-textured. The carbonate zone below 10 to 20 inches is a gray, compact, structureless, sandy loam, grading into stratified, sandy, gravelly material with depth. The more gravelly and sandy tracts are found along the perennial streams heading in the Bear Paw Mountains.

Topography and utilization.—Cheyenne gravelly loams occur as low, gently sloping terraces in the pre-glacial valley of Missouri River south of Fort Assinniboine. The gravelly loams cover 13 square miles, which are shown as farm grazing on the land classification map. Fifteen per cent of the land was under cultivation in 1924. The cropped acreage was confined largely to the tracts around Laredo. Spring wheat was the chief crop grown and yields are about equal to those obtained on the Scobey sandy loams. The surface acre-foot contains about the same amount of plant food as the latter soils.

Vegetation.—Cheyenne gravelly loams are fairly well grassed over with grama grass, nigger wool, and sand grass. On the very sandy phases the tall grasses, such as *Andropogon furcatus* predominate. The carrying capacity of the Cheyenne loams is around 30 acres per head.

ORMAN CLAY LOAMS

Description.—The surface 2 inches of the Orman clay loams is a loose, dull grayish-brown, granular, silty clay mulch. The humus-

bearing layer is a brown, plastic, rather compact, cloddy, silty clay loam. The subsurface layer is a compact, cloddy, brown, silty clay, effervescing faintly with acid. The carbonate zone below 14 inches is a grayish to brown, structureless, compact, silty clay, grading into a structureless, olive-brown clay with depth. The lime occurs largely in streaks and blotches in the upper part of the carbonate zone.

Topography and utilization.—Orman clay loams occupy level to undulating depressions 5 to 15 feet below the Cheyenne gravelly loams in the pre-glacial valley of Missouri River. The clay loams cover 6 square miles, all of which is classified as farm grazing land. In 1924, 15 per cent of the area was under cultivation. Spring wheat was the chief crop. Some of the depressions receive the run-off from the higher tracts and are valuable hay lands. The soils contain a fair amount of nitrogen and are well supplied with phosphorus and lime. The soils are rather retractive, unless mellowed by frost. The average yields of small grains are somewhat lower than on the Marias clay loams.

Vegetation.—The Orman clay loams are well grassed over with western wheat grass. The carrying capacity of the heavy loams is between 20 and 25 acres per head.

LAUREL LOAMS

Description.—Laurel loams in the valleys of the Milk and Marias rivers and the North Fork of Milk River are calcareous, stratified sands, silts, and clays, without distinct horizons. Sandy loams predominate on the terraces in the upper part of Milk River and in the valley of West Fork. The wash below the more eroded breaks consists largely of gray silt to fine sandy material, which often has a glazed crust on the surface. Dark-colored, retractive, alkaline clays occur at the mouth of Sage Creek; and above Gildford rather dark-colored silts and silty clay loams predominate, except for a greasewood flat below the mouth of Tootsie Creek. The bottom lands along Big Sandy Creek are heavy silty clay loams, and in the lake depressions north of Fort Assinniboine are sandy loams and loams. The soils in the bottoms of the smaller streams are usually poorly drained, alkaline, silt to silty clay loams.

Topography and utilization.—Laurel loams cover the first stream bottoms and the light-colored glacial lake beds. The larger tracts are found in the valleys of the larger streams, such as the Milk and Marias rivers, and Sage and Big Sandy creeks and North Fork of Milk River.

The flood plains of most of the streams are narrow, and are often cut into irregular tracts by the meandering of the streams. Laurel loams cover 78 square miles, of which only 2 square miles is shown as farm grazing land on the classification map.

Laurel loams are not under cultivation unless the land is sub-irrigated or water is available for irrigation. The heavy loams are rather retractive. The soils are usually well supplied with the mineral plant foods. Most of the irrigated lands are in native grass, such as native blue-joint, and in forage crops, such as alfalfa. In 1924 a very small acreage was devoted to spring wheat and other small grains.

Vegetation.—Grama grass, nigger wool, valley sage, and prickly pear predominate on the more loamy, sandy tracts of the Laurel loams, and western wheat grass on the heavier loams. Black sage and greasewood cover the wash below the shaly breaks, and salt grass (*Distichlis spicata*) the more alkaline, poorly drained depressions. Trees and large shrubs are confined largely to the better-drained, lighter-textured loams along the streams. The live-stock carrying capacity of the Laurel loams in general is low.

LAUREL CLAY LOAMS

Description.—The surface 4 inches of the Laurel clay loams, such as are found in the bottom of Wild Horse Lake, is a non-calcareous, checked, cloddy, grayish-brown clay. It overlies a compact, dull-brown clay, grading into a tough, plastic, lighter-colored clay at 10 inches, and effervescing weakly with acid. Below 20 inches the subsurface material is a massive olive-brown clay, flecked with white alkaline material, also effervescing weakly with acid. The irregular clods have a platy structure and a glazed colloidal surface. The soils in the old lake basins along Lohman's Coulee have a similar profile development.

The Laurel clay loams at the mouth of Sage and Tootsie creeks are massive, olive-brown, stratified, slightly calcareous clays, which usually have a grayish-brown, compact crust on the surface. Patches of gray, ashy, alkaline material, probably gypsum, occur in the soils at depths of 12 to 15 inches. Cracks penetrate the soils to a depth of one foot or more.

Topography and utilization.—Laurel clay loams cover the darker-colored heavy bottoms along streams and in old glacial lake beds. The heavy loams cover 33 square miles, of which only a few square miles lie outside the bottom of Wild Horse Lake. The soils are too retractive for cultivation and are used for grazing.

Vegetation.—The bottom of Wild Horse Lake is quite barren. A light stand of beggar weed covers most of the bottom and squirrel tail grass (*Hordeum jubatum*) makes a fair growth in the poorly drained sections. Western wheat grass forms a fair cover on the better-drained soils in the valleys of the streams above the greasewood flats. The carrying capacity of the Laurel clay loams is very low.

BAD LANDS

The more eroded exposures of Judith River and Two Medicine formations along Milk River are shown on the maps as bad lands. In a more detailed survey, the shaly breaks along Marias River would also be shown as bad lands. The total area covered with bad lands amounts to 11 square miles in Hill County.

The eroded breaks of the Milk and Marias rivers have a very poor cover of grass. Grama grass and nigger wool form the principal cover on the sandstone breaks, and black sage and greasewood on the shaly breaks. Bad lands are among the poorest grazing sections in the county.

ROUGH BROKEN LAND

Rough broken land covers a total of 107 square miles in Hill County. It consists chiefly of bald peaks, barren ridges, rocky ledges, and talus-covered slopes in the Bear Paw Mountains.

The soils developed above the quaking aspen belt at elevations over 4500 feet have black surface soils consisting largely of organic matter and averaging 6 inches thick. Between 6 and 14 inches the soils are light-brown, compact loams, grading into reddish-brown, structureless silts and silty clays. The carbonate zone below 30 inches is a grayish-brown, silty clay loam becoming more friable with depth. Angular fragments of rock are distributed through all the layers and become more abundant with depth. Carbonate zones were not found in the high basins and on the higher slopes covered with dense stands of lodge-pole pine. The subsoils of these tracts are reddish to brown, heavy-textured loams, grading into friable, dull brown, stony silt loams with depth.

Fair stands of lodge-pole pine are found in the high basins and on the higher slopes of the mountains. Quaking aspen and willows are confined more largely to the more moist slopes and gulches. Sedges predominate over the grasses in the open parks. Shrubs are abundant and form most of the undergrowth. Rough broken land has a low

carrying capacity for cattle but ranks rather high for sheep and goats. Snow covers the mountains for several months in the year.

AGRICULTURE

Stock raising was the chief industry in Hill County up to about 1910, when the public lands were settled and fenced under the so-called "dry-land movement." The breaking out of the prairies and the acquisition of land were the more noticeable features between 1910 and 1917. Crop yields were very favorable during this period, especially in 1915 and 1916, and land values rose rapidly. A severe drought occurred in this part of the state between 1917 and 1921 and the cropped acreage was greatly reduced while the marginal farm lands were abandoned. Land values were greatly deflated during the drought and agricultural depression, and a large acreage of farm and grazing land passed into the hands of mortgage holding companies or was turned over to the county for the non-payment of taxes. In 1925, 63 per cent of all the farm lands carried a mortgage indebtedness of $5.45 an acre on land valued at $10.56 an acre. The conditions in the county have greatly improved the past few years, but land values have not yet become firmly established.

Data taken from the census reports for 1920 and 1925 indicate the agricultural trend which has taken place in the county since the time of the drought. The total area in farms decreased from 59.9 per cent in 1920 to 42.6 per cent in 1925. During this period the number of farms decreased from 2257 to 1421, while the average size of the farms increased from 490.7 to 555.5 acres. Tenancy increased from 4 per cent to 20.8 per cent. The total area in cropped land in 1925 was 343,745 acres, of which less than one-fourth was idle or summer fallow land. The agricultural income for Hill County is derived largely from the sale of products grown on the dry-land farms and from live stock. Live stock and live-stock products make up from one-third to one-half of the gross income.

Stock raising.—Peppin and Broadwater, who operated under the protection of Fort Assinniboine, soon after the fort was established in 1879, were the first to run stock at large in the county. Other cattle organizations did not move their herds across the Missouri and Marias rivers until the Blackfeet Indian Reservation was thrown open for settlement, in 1887. In the early days stock was run at large on the open range without winter protection, but since the settlement of the range land most stockmen provide a few months' winter feed,

consisting chiefly of alfalfa, native grass, and small grain hay. On the dry-land farms the winter grazing land is usually supplemented with straw. The winters in this part of the state are usually open, with light snowfall, and often stock is carried through without supplementary feeds. The beef breeds found on the range are chiefly Herefords and Shorthorns or their crosses. In 1920 there were 14,225 cattle in the county and 19,389 head were reported by 1925. About one-fourth of the total number in 1925 were classed as dairy stock, of which probably more than one-third were cows of the beef breeds used for milking purposes, and the remainder chiefly Holsteins.

Sheep were brought into the county during the early nineties but their numbers have varied with the price of wool. Sheep are grazed in the poorer agricultural districts, such as in the northeastern, western, and southern parts of the county. In some sections waterholes are filled only during the spring and early summer months and the bands are trailed from one grazing area to another as the holes dry up. The fine-wool breeds, such as the Rambouillet or their crosses, are usually found on the range. The number increased from 16,671 in 1920 to 18,130 in 1925.

The vegetation and character of the range is somewhat better adapted to the grazing of cattle and sheep than of horses. In 1925 the number of horses reported on the farms was 15,091, of which 1761 were less than 2 years old.

The swine industry has shown a steady growth since the time of the drought. The total number of swine on the farms in 1925 was 3550, of which 1087 were breeding sows. The Duroc Jersey is the most popular breed.

Dry-land farming.—The State Department of Agriculture and Publicity places the total cropped acreage in Hill County for the past 4 years at approximately 250,000 acres. The land under cultivation is non-irrigated except for a few thousand acres. The acreage and yields of the more important crops are presented in Table 4 which has been compiled from the United States census and state reports.

The dry-land crops grown under the climatic conditions of north-central Montana are chiefly the medium early maturing varieties. The more important varieties of small grains grown in this part of the state are Marquis wheat, N. D. R. No. 114 flax, Markton and Sixty Day oats, Horn barley, and Rosen rye. Winter grains, except fall rye, winter-kill too frequently to be depended upon in the plains, but Karmont and Newturk winter wheat are grown with fair success

TABLE 4.—ACREAGE AND YIELDS OF THE MORE IMPORTANT CROPS GROWN IN HILL COUNTY

	[1]*1919		*1924		**1928		Average **1922-1928	
	Acreage	Acre yields	Acreage	Acre yields	Acreage	Acre yields	Acreage	Acre yields
		Bu. or tons		Bu. or tons		Bu. or tons		Bu. or tons
Cropped land harvested	78,241	—	223,725	—	261,815	—	233,791	—
Fallowed land	—	—	99,756	—	—	—	—	—
Cropped land total	—	—	343,745	—	—	—	—	—
Barley	93	4.3	4,074	13.6	6,400	31.0	4,800	20.7
Beans	—	—	20	4.5	215	21.0	250	15.6
Corn, total	160	—	8,800	—	5,000	18.0	7,055	18.5
Corn, harvested for grain	79	3.0	567	16.0	—	—	—	—
Corn, cut for fodder and ensilage	81	0.6	3,858	2.5	—	—	—	—
Corn, hogged off	—	—	4,375	—	—	—	—	—
Flax	2,030	0.7	2,016	4.1	2,300	9.5	2,100	6.7
Hay, tame total	25,451	—	12,666	1.6	12,200	2.1	10,550	1.7
Hay, wild total	1,836	0.5	2,774	1.0	1,900	1.1	2,660	0.9
Hay, alfalfa	863	1.3	2,890	—	—	—	—	—
Hay, other legumes and grasses	561	0.5	1,869	—	—	—	—	—
Hay, small grains cut for hay	24,027	0.2	7,907	—	—	—	—	—
Oats	2,074	3.0	16,630	17.8	16,000	30.0	18,285	25.5
Potatoes	368	34.4	390	95.7	700	120.0	621	95.5
Rye	2,880	3.0	2,336	11.0	5,000	13.0	7,285	10.1
Wheat, total	43,085	2.5	175,752	—	233,000	—	182,845	—
Wheat, fall	—	—	3,000	18.0	18,000	10.0	6,845	9.7
Wheat, spring	—	—	172,000	13.0	215,000	21.0	176,000	13.1

*United States census reports.
**Montana Department of Agriculture reports.
[1]Extremely dry year.

on the higher slopes of the Bear Paw Mountains. Northwestern Dent corn and the flints are maturing sufficiently in normal seasons for grain and fodder. Spring wheat is the most important crop grown in the area and the acreage has steadily increased. In 1928, 215,000 acres were reported. Flax is a profitable cash crop on new breaking but on old lands the yields are very low. More than one-half of the acreage devoted to oats and barley is harvested for hay. The acreage of corn harvested for grain is very small, as most of the corn is cut for fodder and silage or harvested in the field by swine and sheep. The average yields of small grains, as shown in the accompanying table, are rather low, so that for profitable farm returns, close attention must be given to the cost of production.

Alfalfa, sweet clover, brome grass, and the native grasses are the chief forage and hay crops. The tame grasses and legumes cover

a rather small acreage, partly because of the difficulty of obtaining satisfactory stands in average seasons, and also because of their low yields, which usually average less than 1 ton to the acre.

The yields of potatoes and other root crops in general are low and only a sufficient quantity is produced for home consumption. During the past few years some attention has been given to the production of seed potatoes, which may develop into an important industry. Gardens and small fruiting shrubs are usually located in protected nooks, where the snow accumulates during the winter months, or in depressions which are flooded during the spring run-off.

The efficient use of small tractors and large horse outfits has characterized the growing of spring wheat on the large grain farms in Montana during the past few years. The annual cropped area on many of the grain farms ranges from 200 to 600 acres or more. Spring wheat and other small grains are usually grown until the land becomes foul, when clean summer fallow is introduced every second or third year. North-central Montana is subject to strong, persistent winds, especially in the early spring, and unless protected the surface soil is likely to drift. Duckfoot cultivators and similar implements which reduce the cost of production, and are fairly efficient in controlling soil drifting are commonly employed on the large grain farms, for preparing the land for spring seeding and for summer fallow. Small combine-harvesters are replacing headers and push binders on these farms. On the smaller farms a greater diversification is practiced. Corn replaces summer fallow to some extent and a greater acreage of forage crops is found. The income from these farms is derived largely from the sale of grain, live stock, poultry, and dairy products. Small herds of cattle and occasionally a band of sheep are found on the smaller dry-land farms, especially in localities where grazing land is available.

Irrigation farming.—The irrigated lands in Hill County occur chiefly in the bottoms of the larger streams, covered with the Laurel loams and clay loams. In the pre-glacial valley of Missouri River, Cheyenne gravelly loams and Box Elder loams are locally under irrigation along the perennial streams heading in the Bear Paw Mountains. The soils of the first stream bottoms are rather retractive alkaline silt and silty clay loams and are often in need of drainage. Alkali occurs chiefly in the form of sulfates, such as sodium sulfate. The irrigated lands are devoted chiefly to pasture and hay crops. Native blue-joint is the most important hay crop, followed by alfalfa. In 1924 the acreage devoted to small grains was small.

SOIL PROBLEMS

Land utilization is probably the most important problem in Hill County at the present time. A large amount of land is held in tracts of 160 to 320 acres or more by non-resident owners, who rent under short time leases for grazing and farming. These tracts should be consolidated into larger farming and grazing units for the most efficient use of the land.

On the non-irrigated farms.—Exclusive grain farming is not considered a permanent system of agriculture, but where a clean summer fallow is introduced every second or third year it can probably be carried on for several generations without noticeable decline in yields of crops, unless outside factors enter in. Because of strong, persistent winds, soil blowing is the most important problem on the large grain farms in Hill County. It is likely to become more prevalent as the root fiber is destroyed by continuous grain growing. Duckfoot and rotary rod weeders are being employed with fair success to check soil drifting. Thus far only a very small acreage has been seeded to pasture and hay crops for this purpose.

Slick spots are rather common on the soils developed over shaly drift in the plains, especially at the head of drainage basins. These spots usually show up in grain fields for many years after the land has been broken. Where they cover 30 per cent or more of the surface of the land they have a noticeable influence on crop growth and yields in unfavorable seasons. The cost of reclaiming scab lands with barnyard and green manures is prohibitive at present land values.

Variations in yields of small grains in different parts of the county are usually attributed to low rainfall and poor farming. The yields of small grains are greatly influenced by the amount and distribution of the rainfall and by the cropping and tillage methods, but a closer study of crop yields and cultural methods on the different soil types may show differences in fertility, which are now attributed to other causes.

On the irrigated farms.—The chief problem on most of the small irrigated projects is an adequate water supply. Other problems, such as the management of the heavier soil types, drainage, alkali, and fertility, have not been given attention.

IRRIGATION

Irrigation has been practiced in Hill County for a number of years. It is confined largely to small projects in the valleys of the

larger streams. Many of these projects depend upon the direct flow of the streams, and in dry seasons water for irrigation is often short. During the dry years storage reservoirs and diversion dams were constructed in the larger coulees for the irrigation of small tracts but most of them have been abandoned. Much of the irrigated land in the county is not assessed as irrigated because of the inadequate water supply.

In 1920 less than 4000 acres were actually irrigated on projects where it is possible to irrigate 12,000 to 14,000 acres. The projects in the pre-glacial valley of the Missouri River southwest of Havre depend upon the direct flow of streams and on small storage reservoirs. A pumping plant on the north bank of Milk River east of Havre supplies water for about 1000 acres. Sage Creek is diverted into several natural reservoirs in the upper part of its valley. These reservoirs have storage capacity for the irrigation of several thousand acres. The McLean reservoir in the northeastern part of the county supplies water for 500 to 600 acres of hay land. Other small reservoirs and diversion dams are distributed over the county.

Several large irrigation projects have been proposed and investigated in this part of the state by the United States Reclamation Service. The Marias River Project contemplates the reclamation of 250,000 acres, of which 160,000 acres lie in the south-central part of Hill County and the remainder in the northern part of Chouteau County. The proposed reservoir and dam site is located on Marias River near Brinkham with Lonesome Lake in Chouteau County providing additional storage. The feasibility of the project depends largely upon the available water supply. Most of the land included in the project is in the area covered by the Scobey loams and sandy loams. The land has an undulating to rolling relief and could be leveled for irrigation without great expense. The soils are well adapted to the growing of cereal and forage crops. The area covered by the proposed project is shown on the land classification map.

WATER AND FUEL RESOURCES

The agricultural development of certain sections of Montana is limited by an inadequate supply of water and fuel for domestic use. The quality of water found in the drift and geological formations varies greatly. The Bear Paw shales underlying the northeastern part of the county carry a very poor quality of water for domestic use. The Judith River formation, which grades into the Two Medicine

formation in the northwestern part, underlies the drift in the central and east-central part of the county. Water from the fine-grained sandstones of this formation is usually of good quality for domestic use. Coal fields are located in Judith River formation near Havre and along Canada Creek in the northwestern part of the county, and workable coal veins are found in the Two Medicine formation. The Claggett shales, outcropping in the southwestern part and in other sections, carry a very poor quality of water. The massive sandstones of the Eagle formation, underlying the drift south of Inverness and Rudyard are the chief source of natural gas in the area. The water found in this formation is usually of good quality. The Colorado shales are often destitute of water for domestic use. In the area underlain with the Bear Paw, Claggett, and Colorado shales, water for domestic use is usually obtained in the deeper deposits of drift, and from the surface run-off impounded in small reservoirs. An excellent quality of water is found in the Bear Paw Mountains.

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DOMINION OF CANADA

LIBERTY COUNTY

BLAINE COUNTY

CHOUTEAU COUNTY

R8E R9E R10E R11E R12E R13E R14E R15E R16E R17E

T37N T36N T35N T34N T33N T32N T31N T30N T29N T28N

SOIL RECONNOISSANCE
MONTANA
1924

HILL COUNTY
LAND CLASSIFICATION
BY
U. S. GEOLOGICAL SURVEY

LEGEND

GRAZING FORAGE LAND
NONTILLABEE GRAZING LAND
IRRIGATED LAND
PROPOSED MARIAS PROJECT

DOMINION OF CANADA

COUNTY

BLAINE

LIBERTY

COUNTY

CHOUTEAU COUNTY

R 8 E R 9 E R 10 E R 11 E R 12 E R 13 E R 14 E R 15 E R 16 E R 17 E

T 37 N T 36 N T 35 N T 34 N T 33 N T 32 N T 31 N T 30 N T 29 N T 28 N

SOIL RECONNOISSANCE

MONTANA

1924

HILL COUNTY

AREA UNDER CULTIVATION

LEGEND

PERCENTAGE OF SECTION IN CROP OR FALLOWED LAND

5 PERCENT	20 PERCENT	50 PERCENT	80 PERCENT
10 "	30 "	60 "	90 "
15 "	40 "	70 "	100 "

DOMINION OF CANADA

R 8 E R 9 E R 10 E R 11 E R 12 E R 13 E R 14 E R 15 E R 16 E R 17 E

T 37 N
T 36 N
T 35 N
T 34 N
T 33 N
T 32 N
T 31 N
T 30 N
T 29 N
T 28 N

COUNTY

LIBERTY

BLAINE

COUNTY

R 9 E R 10 E R 11 E R 12 E R 13 E R 14 E R 15 E R 16 E R 17 E

CHOUTEAU COUNTY

SOIL RECONNOISSANCE
MONTANA
1924

HILL COUNTY

SOIL AREAS

LEGEND

SOIL SERIES AND TYPES

- BAINVILLE LOAMS
- BLAINE LOAMS
- BOX ELDER LOAMS
- CHEYENNE GRAVELLY LOAMS
- JOPLIN CLAY LOAMS
- JOPLIN LOAMS
- JOPLIN SILT LOAMS
- JOPLIN STONY LOAMS
- LAUREL CLAY LOAMS
- LAUREL LOAMS
- MARIAS CLAY LOAMS
- ORMAN LOAMS
- PIERRE CLAY LOAMS
- PHILLIPS LOAMS
- SCOBEY LOAMS
- SCOBEY SANDY LOAMS
- SCOBEY STONY LOAMS
- WILLIAMS LOAMS

PHYSIOGRAPHIC FEATURES

BADLANDS MOUNTAINS

DOMINION OF CANADA

R 8 E R 9 E R 10 E R 11 E R 12 E R 13 E R 14 E R 15 E R 16 E R 17 E

T 37 N T 36 N T 35 N T 34 N T 33 N T 32 N T 31 N T 30 N T 29 N T 28 N

COUNTY

BLAINE COUNTY

LIBERTY

CHOUTEAU COUNTY

KENNEDY COUL. · TROY · CANADIAN · KING · COLDSTONE · FAIRCHILD · BUTTE · SIMPSON · OLDHAM · SPRING CREEK · WILD HORSE LAKE · MILK RIVER · MILLER · LILACS · CREEDMANS COUL. · WEST FORK · WOODHILL COUL. · SIGNAL BUTTE · PHIPPS · MILK RIVER · McLEAN RES. · COTTONWOOD CREEK · STATIONS COUL. · LOHMANS COULEE · AMOS · ST. JOSEPH · THIBEDEAU LAKE · TOOTSIE · SAGE CREEK · HAUSMAN · COTTONWOOD · TOSLAND · CASADY · ARCHIE COULEE · O'BRIEN COULEE · REDROCK · COAL COUL. · DRY LAKE COUL. · CHAIN LAKES · ALKALI COUL. · SAGE CREEK · GILFORD · GREAT NORTHERN RAILWAY · XENIA · KREMLIN · FRESNO · BURNHAM · TOLEDO · INVERNESS · RUDYARD · HINGHAM · HAVRE · HAVRE AGRI. EXP. SUBSTA. · SADDLE BUTTE · ASSINIBOINE CR. · FAULKNERS COUL. · FOURTEEN MILE COUL. · HALF WAY COUL. · BIG SANDY CREEK · BLACK COULEE · BARNEYS COUL. · BIG SANDY CREEK · MISSOURI R. · OSCAR · BULLHOOK CR. · ELDER CR. · MT REYNOLDS · MT BATES · MT OTIS · BOX ELDER CR. · AGENCY · BRINKMAN · MARIAS RIVER · ROCKY BOY INDIAN RES. BOUNDARY LINE · BOX BEAVER CR. · MT BEARPAW

SOIL RECONNOISSANCE
MONTANA
1924

HILL COUNTY

TOPOGRAPHY

LEGEND

BADLANDS
BEARPAW MOUNTAINS
PRE-GLACIAL MISSOURI VALLEY

UPLANDS LEVEL TO ROLLING PHASE
UPLANDS SHARPLY ROLLING PHASE
STREAM AND LAKE BOTTOMS
VALLEY BENCHES